Human Blood Relationships.

THE idea that a loss of blood by hæmorrhage or the possession of blood of a poor and deteriorated quality might best be rectified by the introduction into the body of blood from a healthy person is of respectable antiquity. It is small wonder that the ancients attributed to so splendid and conspicuous a tissue an importance rather beyond its due. About the time of the fire of London Pepys attended experiments in which the blood of one dog was passed into another and found to be sufficient for its needs, and on another occasion at which a man was hired for a sovereign to have some sheep's blood let into his body. For even at this time it was realised that some sorts of blood were more suitable for transfusion into man than others. Little boys might be bled to death in the fifteenth century to provide stimulating potions for aged Popes, but human blood seems scarcely to have been available in Lower's time, and the choice generally fell on the sheep, partly because of its gentle and amiable disposition and partly "quia Christus est agnus Dei," as Coga said, an indigent bachelor of divinity who subjected himself to the experiment in 1667. But transfusion of blood never became an important or popular therapeutic procedure on these terms; large quantities of foreign blood were found to cause serious and even fatal ill-effects and small amounts did no good. With the discovery of the last thirty years that the tissues of any one species of animal are foreign and more or less poisonous to the economy of any other species came the recognition that transfusion in man could be done only with human blood, and in recent years the value of the procedure has been fully established, large quantities being transfused from a healthy to a sick person without untoward effect.

In this revival of human transfusion it was, however, soon found that the capacity of the body to identify any blood as foreign to and incompatible with its organisation was based on finer distinctions than zoological species. If from a dozen people a few cubic centimetres of blood are withdrawn, and in each case preparations made of the serum and of the red corpuscles washed free from serum, and if a sample of each lot of corpuscles is then mixed with a little of each serum in a series of test-tubes, it will be found that the results are not all the same. In some the corpuscles behave as if they were suspended in physiological salt solution—remain dispersed from one another and intact; in other cases they run together into larger or smaller clumps and masses and often disintegrate. It is obvious that the occurrence of this agglutination in the circulating blood is very undesirable, as the masses of corpuscles are liable to block important blood-vessels, and there is plenty of experience to show that serious trouble may be caused in this way. It is therefore not every human blood that is suitable for transfusion into a given person.

By sorting over a large number of people by this test it has been found that they may be classified into four groups by the satisfactory hypothesis of von Dungern and Hirschfeld. On this view there are two agglutinating factors in human blood serum (*a* and *b*) and two agglutinable factors (A and B) in human blood corpuscles: A corpuscles will react only with *a* serum, *b* serum only with B corpuscles. A is never found in the same person as *a*, nor B with *b*; either combination would be incompatible with life. The blood characteristics of the four groups are:

	Serum.	Corpuscles.
Group I. . .	neither	A and B
Group II. . .	*b*	A
Group III. . .	*a*	B
Group IV. . .	*a* and *b*	neither

It follows that the serum of Group I. will not agglutinate anybody's corpuscles, while the corpuscles of Group I. are agglutinated by all other sera except their own. Group IV. is the reverse of this, while the serum of Group II. agglutinates the corpuscles of Groups I. and III., and the serum of Group III. the corpuscles of Groups I. and II. The corpuscles of Group I. can safely be put only into recipients belonging to the same group, those of Group II. only into Groups I. and II., those of Group III. only into Groups I. and III., those of Group IV. into anybody. It is a curious fact that in actual practice it is only the qualities of the donor's corpuscles and the recipient's serum which need be considered. When, for example, Group IV. blood is transfused, the plasma of it should agglutinate the corpuscles of the recipient if the reaction took place as it does outside the body. This does not appear to happen, or if it does it produces no obvious ill-effects—which is fortunate, as otherwise safe transfusion would be impossible except between members of the same group. Why this should be so is at present doubtful. It is most probably due to the quantity of transfused plasma being insufficient, when diluted with the recipient's blood, to cause a significant agglutination of the recipient's corpuscles. The fact that it is plasma which is injected and not serum may also have some influence, though the recipient's plasma has the same effect as his serum, at any rate qualitatively.

While it is convenient to recognise four varieties of individuals, it will be seen that there are only two factors concerned. A is characteristic of Group II., and B of Group III.; A+B are present in Group I., and both are absent in Group IV. A corpuscles are necessarily associated with not-*a* serum, and B corpuscles with not-*b* serum. In inheritance these qualities have been shown to be transmitted as straightforward Mendelian factors. It follows that the blood of parents and children are by no means necessarily compatible: though parents both of Group IV. can produce children only of the same group, two Group I. parents may have offspring belonging to any group, according to the particular composition of their hybridity. The possibility of using these blood reactions to investigate cases of disputed parentage has been carefully worked out by Ottenberg, who shows that the method can have but a limited application, though the answers are conclusive if they can be obtained at all. Of much interest also is the observation that the proportion of the population falling into Groups II. and III. varies a good deal in different races. In England about 40 per cent. are Group II., about 15 per cent. Group III., Groups I. and IV. giving about 2

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and 43 per cent. respectively. Several workers, and especially the Hirschfelds, have shown that as one travels from west to east the prevalence of Group II. (A) decreases and that of Group III. (B) progressively rises. In Western Europe, A is found in about 45 per cent., in Russians and Arabs in 37 per cent., in negroes and Indians in 27 per cent. B, on the other hand, increases from about 15 per cent. in France, through the Balkans (20 per cent.), Malagasies (28 per cent.), negroes (34 per cent.) to Indians with 49 per cent. We have here an obvious suggestion of two original races of mankind, which have mingled in various degrees: it is possible that in some remote place a pure A or B variety still exists.

At present there is no evidence that these blood characteristics are associated with any other qualities, and it seems likely, like some other Mendelian characters, that they are negligible in the problems of selection and survival. It would, too, be an error of the ancients to suppose that the qualities of the blood dominated personality and conferred a general characteristic on the individual. There is much evidence of the essential similarity of parents and offspring. The greater success of grafting tissues from one animal to another if they are of the same family is a germane example. In blood tests brothers and sisters by no means always agree so far as the agglutination of their corpuscles is concerned: in other respects their bloods are probably more similar than those of more remote relations.

The History of the Photographic Lens.

DR. REGINALD S. CLAY performed a needed and useful service when he selected for the subject of the twenty-fifth annual Traill-Taylor Memorial Lecture, which he delivered at the meeting of the Royal Photographic Society on October 10 last, "The Photographic Lens from the Historical Point of View." It was a needed service, because a historical review of the origin and development of the photographic lens is necessary for a just estimate and balanced perspective of the many and diverse scientific factors that have to be taken into account in the production of modern photographic lenses. It was a useful service, because the fascinating and, at times, almost dramatic story that Dr. Clay had to tell brings out clearly the paramount importance of the pioneer work done in this field by British firms and scientific workers, and it must act as a useful corrective to the tendency, sometimes manifested in unexpected quarters, to underrate the value of British work in the optical field.

After touching lightly on the early history, Dr. Clay comes to "one of the great landmarks in the history of optics—the invention of the achromatic lens." John Dolland, after numerous experiments, exhibited to the Royal Society an achromatic prism in 1758 of crown and flint glass, and explained its construction. Of the authors who contributed, in this period, before the invention of photography, to the theoretical treatment of the lens, Dr. Clay instances, after Kepler, the following:

> Huygens, who, besides expounding the wave theory of light and the explanation of double refraction, also dealt with the spherical aberration of lenses, and showed how it varied with their aperture and focal length; Newton, who investigated the dispersion of light; Joseph Harris, who discussed the cardinal points, optical centre, oblique pencils, curvature of field, etc., in his "Treatise of Optics"; Herschel, who obtained valuable equations for the calculation of objectives free from chromatic and spherical aberration; George Biddell Airy, who investigated the conditions for eliminating astigmatism and distortion; William Hamilton, who evolved powerful mathematical methods which even yet have not been fully utilised; and, last but not least, Henry Coddington, who worked out the methods which, I believe, still form one of the most useful bases for attacking new problems in lens construction.

The next milestone marks the almost simultaneous announcements of the inventions of photography by Daguerre in 1838 and Fox Talbot on January 30, 1839, and we reach "the epoch from which we may date the great evolution of the photographic lens." After referring to the photographic lenses of Charles L. Chevalier, Dr. Clay comes to the work of Josef Max Petzval (1807–1891), who computed a new and most successful lens, corrected for spherical aberration over a small angular field, which was made by Frederick Voigtländer in 1840.

We may pass over much interesting record and come to a new chapter, opened in 1866 with the aplanatic lenses of Steinheil and Dallmeyer. Steinheil, "beginning to recognise the value of symmetry in reducing astigmatism and distortion," concluded that the astigmatism would be less if the refractive indices of the glass were more nearly equal; he therefore used two flints instead of flint and crown, putting the higher refractive glass outside. Dallmeyer also used two flints, and called his first lens a "wide-angle rectilinear lens," 1866. It worked at f/15, and he followed it by his symmetrical at f/7 and f/8. In 1874 Steinheil made a portrait lens of two cemented lenses working at f/3·5, and in the same year Ross brought out their portable and rapid symmetrical, calculated by F. H. Wenham. "This is of interest," says Dr. Clay, "as Ross and Co. (as the firm then was) was thus the first firm to employ a scientific man as calculator. Wenham was with them from 1870 till 1888."

The next step, which Dr. Clay describes as "the greatest step in the development of the photographic lens," was made possible by the new glasses—the barium crowns of the Schott glass factory at Jena. The problem and its solution is thus expressed:

> An achromatic lens of ordinary crown and flint, which we may call an "old achromat," could be corrected spherically, but not made anastigmatic. An achromatic lens made of the new barium crown and a flint could be corrected for astigmatism, but not spherically. To correct both, all three glasses must be used—old crown, flint, new barium crown. To take full advantage of this principle, it is obvious that each component can be made of all three glasses. It can then be achromatic, anastigmatic, and aplanatic. By combining two such components into a symmetrical lens, it can also be made orthoscopic, and can easily be given a flat field. This is the principle underlying the well-known Goerz lenses. Another way to achieve the result is to use two unlike combinations, one of which is made responsible for

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